Paper ID: 66464
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IAF SPACE POWER SYMPOSIUM (C3)
Joint Session on Advanced and Nuclear Power and Propulsion Systems (5-C4.10)

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UTILIZATION OF HELIUM COOLED NUCLEAR REACTORS FOR POWER GENERATION AND TO CONDUCT SCIENTIFIC EXPERIMENTS ON MOON

Abstract

As the closest space-based natural satellite in space, the moon has been a major interest of the space community which led to the concentrated efforts in Apollo missions, Clementine probe and the Artemis Program. Nuclear power sources proves to be more lucrative in overcoming the constraints of power requirements by the classical chemical systems under reduced gravity conditions. The requirement, stability and control conditions for fuel to be transported from Earth will be a cumbersome process if pursued via classical methodologies. On the moon, it will be imperative to have extensive power generating support for various locomotive and logistical requirements. Additionally, it is exigent to perform scientific experiments along with the facilities to process materials in space. With availability of a nuclear reactor, all the power requirements of a lunar station can be met for several years without any perplexities. Unfortunately, the standard type of reactors operating on Earth are not feasible for lunar base. The control of fission kinetics on the moon will be incommodious and using water as a coolant will be impractical due to its 16.6 percent of Earth's gravity. In a Helium Cooled Nuclear Reactor, Helium is used both as a neutron moderator and as a coolant which imparts the thermodynamic efficiency of this reactor up to 48 percent. Since helium is an inert gas, it is not chemically reactive with the radioactive fuel and Helium circulation enhances under reduced gravity to microgravity conditions. Thus, pumping and cycling of Helium would be easier and the logistics of by-products will not be problematic. The paper encompasses the parametric study of outlet temperature, turbulent kinetic energy by the computational fluid dynamics of the operation on an optimized design of a Helium Cooled Nuclear Reactor. To boot, the paper discusses the associated issues while addressing moon-based criteria of reduced gravity, lack of atmosphere, availability of large amounts of charged lunar regolith and lack of natural resources necessary for the operation of such a system in order to develop amicable solutions. The exigent scientific experiments that can be conducted by the output power are also presented in the paper.